HPA axis in Central Stress Response System, General Adaptation Syndrome & Transactional model of stress

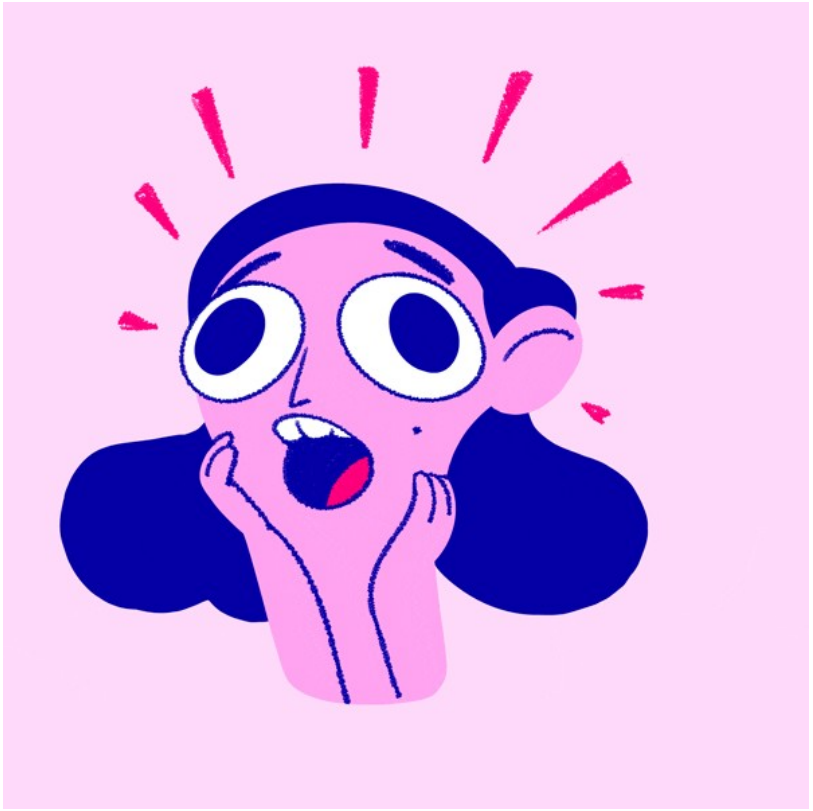
S.Lakshmanan,
Psychologist, and Ex. Project Officer, NYK, Puducherry.

Stress and Health

- Stress is the nonspecific response of the body to any demand made upon it.
  - Failing grades
  - Scary movie
  - Even positive events in your life such as:
    - Graduation
    - New job
- Stress activates the Autonomic Nervous System rapidly
- Stress activates the Hypothalamus-Pituitary-Adrenal (HPA) Axis more slowly.
- Both systems have major effect on health and well-being.

Short term reaction to stress

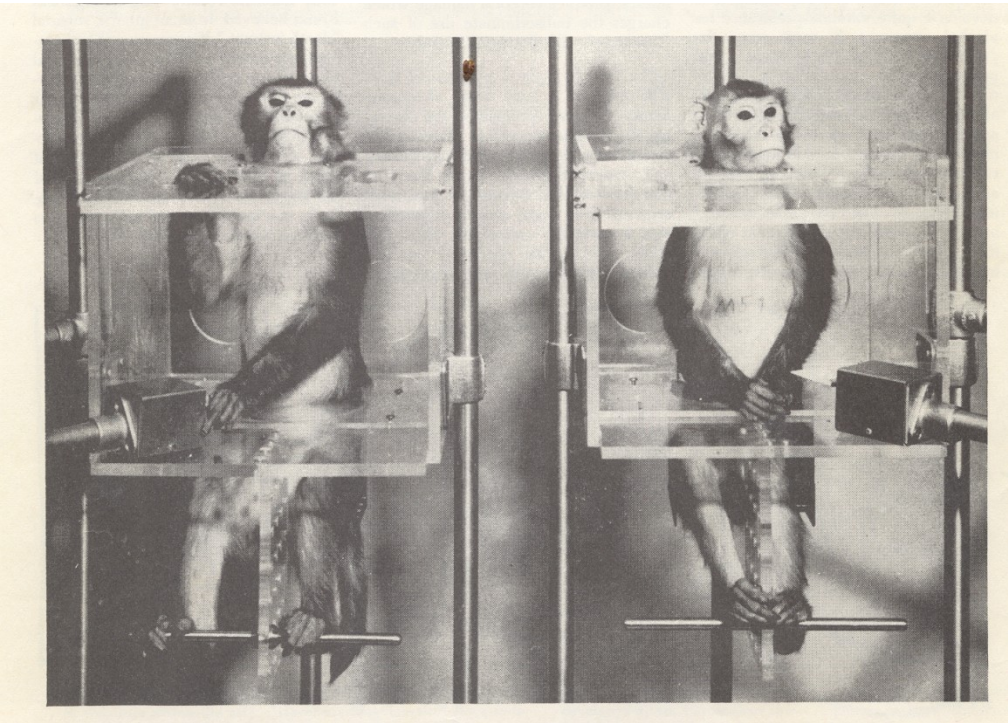
- Level of responsiveness
- Sympathetic NS easily triggered.
- Hostile heart syndrome.
- Tense, impatient.
- Road rage causes 4X more accidents than drunk driving.



Executive Monkey (Brady)

- Pair of monkeys.
- Both could get shock.
- One monkey could press bar to avoid shock for him and his yoked control.
- Monkey with active bar called “active” monkey.
- Other monkey in pair called “passive”.
- One member of pair likely to get ulcers.
- Which one?

Brady's experiment



- Active monkey is on the left.
- Press lever to avoid shock.
- Passive monkey is on the right.
- Pressing the lever does not affect shock delivery

Brady's mistake

- Brady found executive (active) monkeys got more ulcers.
- First monkey to learn task active.
- Attempts to replicate yield the opposite result: passive monkeys get ulcers.
- Passive monkeys lack control over situation.
- More stressful if you have no control over occurrence of stress.

Reducing the effects of stress

- Stress is less harmful if
- Have some control (even if just belief).
- Predictable (“going to feel a little pinch”).
- Know the duration.
- Coping mechanism.
- Some way to relieve stress.
- Positive attitude.
- Active participant in process.

an organism's response to a stressor

- **Stress**, either physiological or biological, is an organism's response to a stressor such as an environmental condition. Stress is the body's method of reacting to a condition such as a threat, challenge or physical and psychological barrier. Stimuli that alter an organism's environment are responded to by multiple systems in the body. In humans and most mammals, the autonomic nervous system and hypothalamic-pituitary-adrenal (HPA) axis are the two major systems that respond to stress.

an organism's response to a stressor

- The sympathoadrenal medullary (SAM) axis may activate the fight-or-flight response through the sympathetic nervous system, which dedicates energy to more relevant bodily systems to acute adaptation to stress, while the parasympathetic nervous system returns the body to homeostasis. The second major physiological stress-response center, the HPA axis, regulates the release of cortisol, which influences many bodily functions such as metabolic, psychological and immunological functions. The SAM and HPA axes are regulated by several brain regions, including the limbic system, prefrontal cortex, amygdala , hypothalamus, and stria terminalis.

an organism's response to a stressor

- Through these mechanisms, stress can alter memory functions, reward, immune function, metabolism and susceptibility to diseases. Disease risk is particularly pertinent to mental illnesses, whereby chronic or severe stress remains a common risk factor for several mental illnesses. One system suggests there are five types of stress labeled "acute time-limited stressors", "brief naturalistic stressors", "stressful event sequences", "chronic stressors", and "distant stressors". An acute time-limited stressor involves a short-term challenge, while a brief natural stressor involves an event that is normal but nevertheless challenging. A stressful event sequence is a stressor that occurs, and then continues to yield stress into the immediate future. A chronic stressor involves exposure to a long-term stressor, and a distant stressor is a stressor that is not immediate.

DUAL STRESS RESPONSE

SAM — SHOCK

COUNTER-SHOCK — HPA

Autonomic Nervous System (Involuntary movements of non-skeletal muscles e. g. heart)

Parasympathetic Nervous system (Involved when body tries to conserve energy, monitors relaxed state, opposite to SNS

Higher brain centres once stress is perceived (Hypothalamus)

FAST — Stimulates — Sympathetic Nervous system (activated in situations needing energy and arousal)

SLOW — Activate — Endocrine System — Releases — Corticotrophin releasing factor (CRF)

Anterior Pituitary gland — Releases — Adrenocorticotrophic hormone (ACTH)

Activates — ADRENAL GLAND

Adrenal Medulla — Releases — Adrenaline, Noradrenaline

Arouses sympathetic ganglia

Increase in energy
Increased alertness (pupil dilation)
Increase blood flow to muscles
Increase heart and respiration rate
Reduce activity of digestive system (reduce salivation-dry mouth)
Increase the output of the heart
[short lived]

Adrenal cortex — Activates — Cortisol (a glucocorticoid) "STRESS HORMONE"

Maintains steady supply of glucose (for energy)
Suppresses the immune system (more likely to develop diseases, catch viruses)
Anti-inflammatory action slows wound healing
[Long term damage]

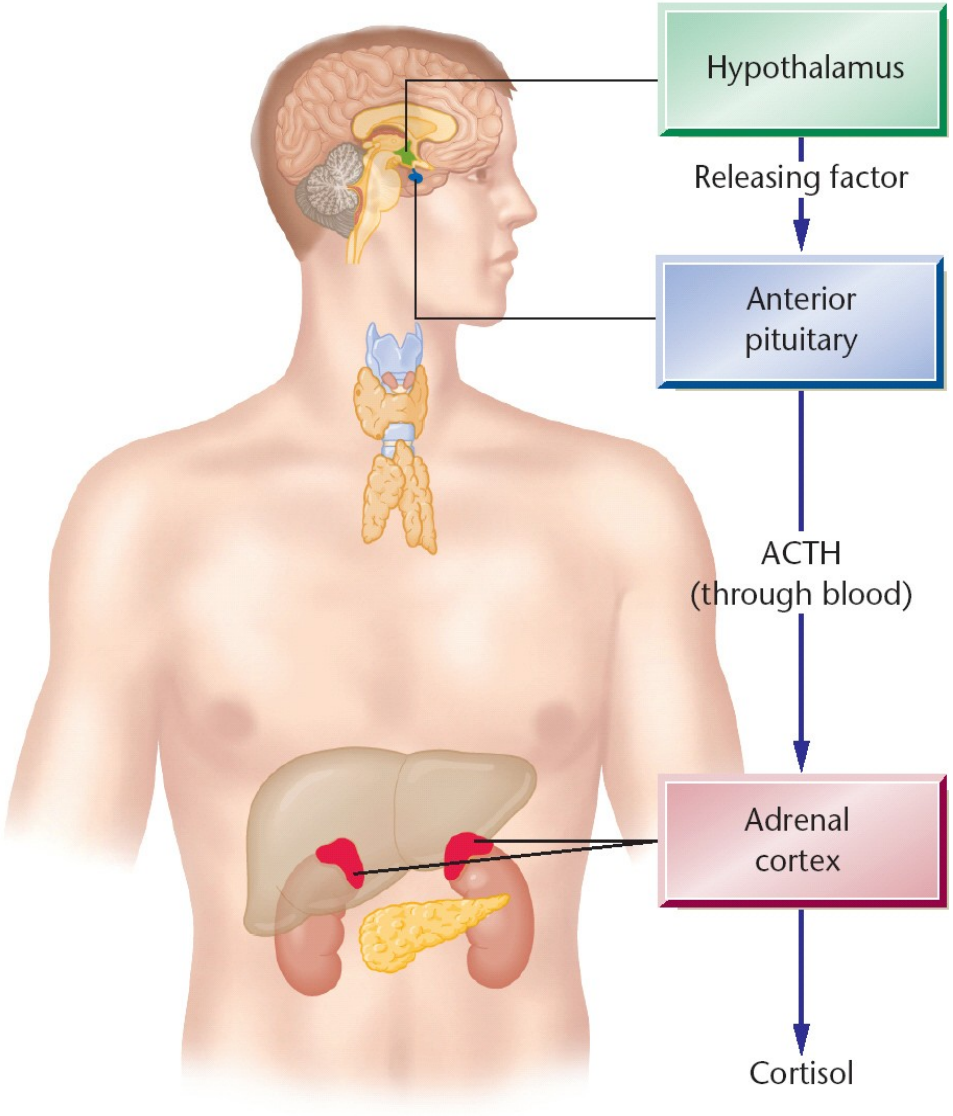
PREPARATION FOR FIGHT OR FLIGHT RESPONSE

Long term stress

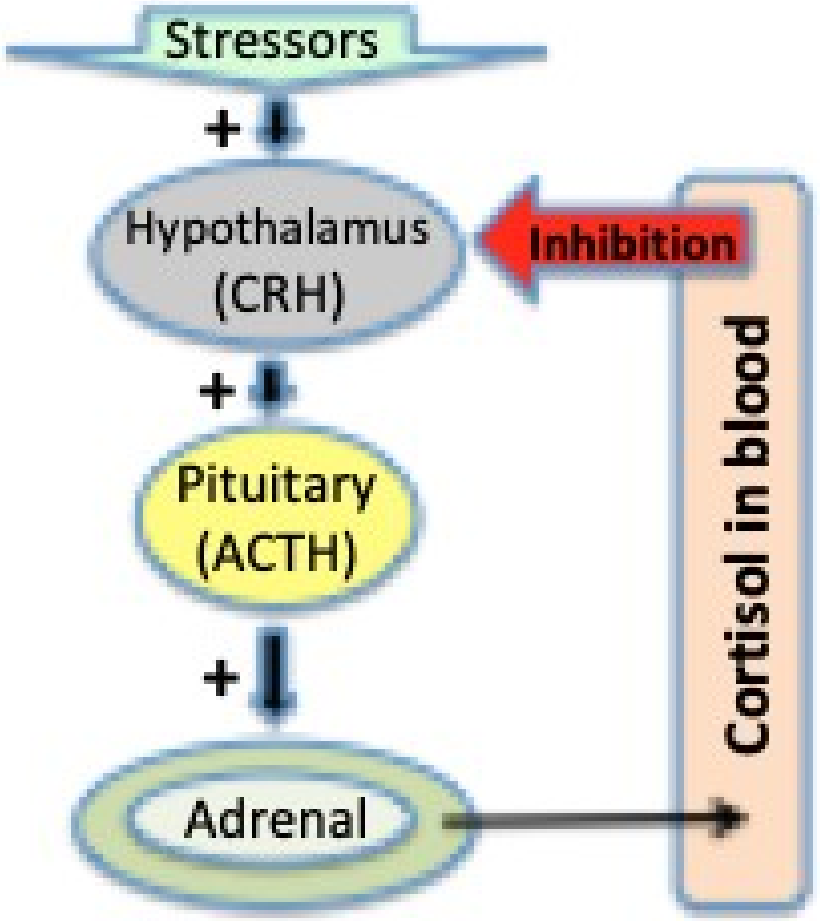
- What if stress continues for months or years?
- Stressful occupations: air traffic controllers
- Whether stress is real or imagined doesn’t matter to the brain and body.
- Respond in the same way.
- Brain activates the adrenal cortex.

Brain and Adrenal Cortex

- Prolonged stress leads to the secretion of the adrenal hormone cortisol
- Cortisol (stress hormone) elevates blood sugar and increases metabolism.
- Body is then able to sustain prolonged activity
- Also reduces inflammation



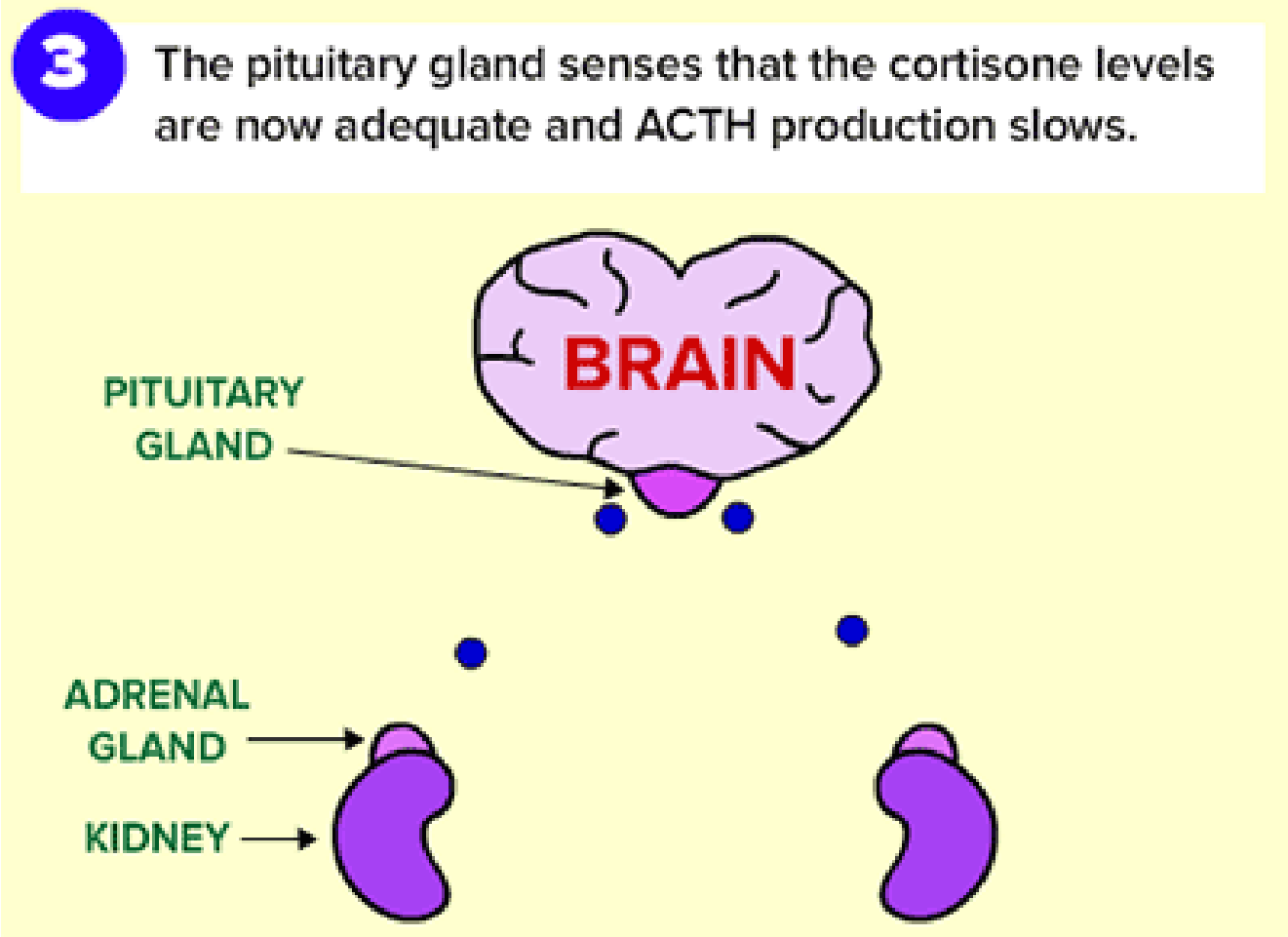
HPA axis in central Stress response system



HPA axis in central Stress response system

The hypothalamic pituitary adrenal (HPA) axis is our central stress response system. The HPA axis is an eloquent and every-dynamic intertwining of the central nervous system and endocrine system.

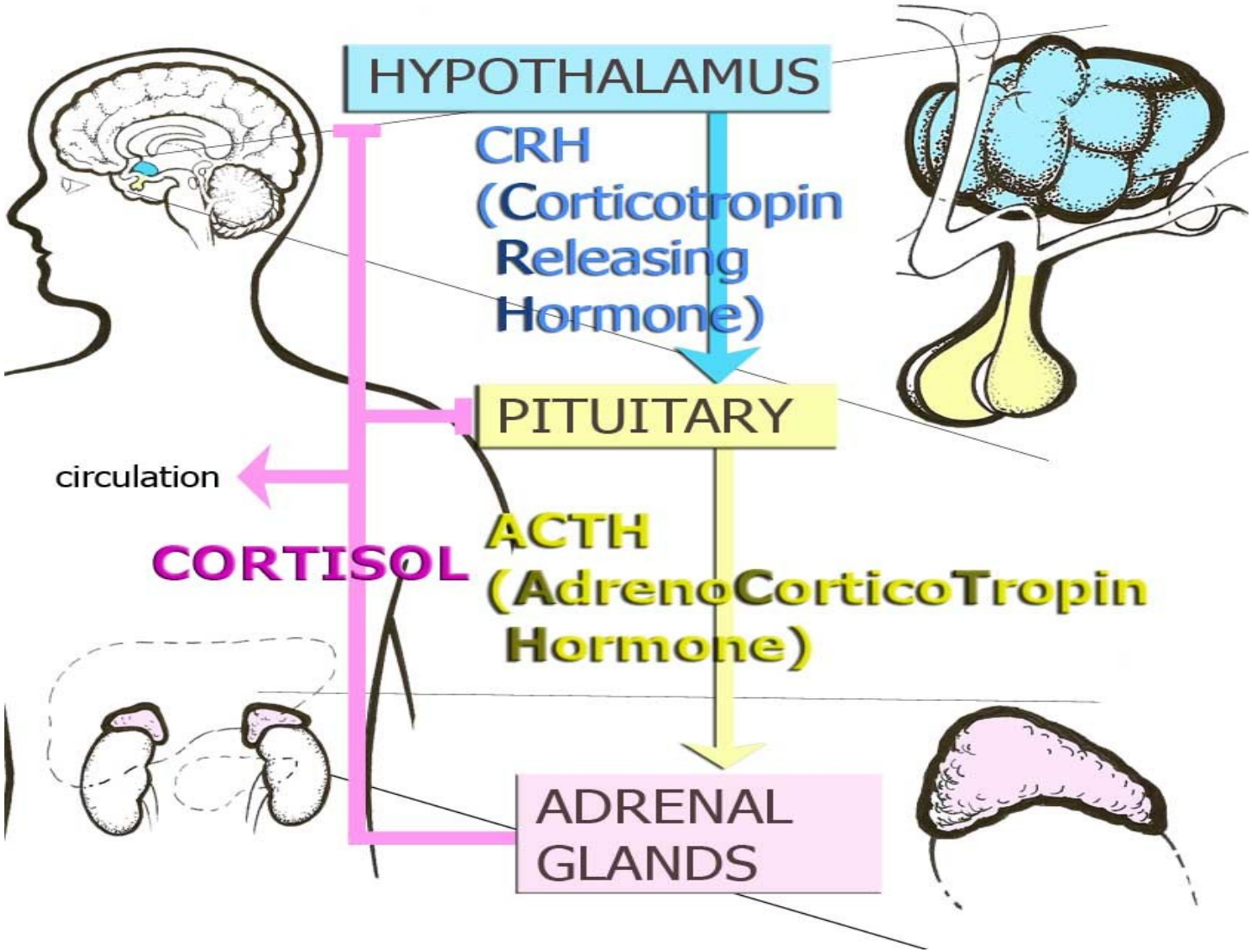
HPA axis in central Stress response system



HPA axis in central Stress response system

This system works in a fairly straight-forward manner. The HPA axis is responsible for the neuroendocrine adaptation component of the stress response.
This response is characterized by hypothalamic release of corticotropin-releasing factor (CRF). CRF is also known as CRH or corticotropin-releasing hormone. When CRF binds to CRF receptors on the anterior pituitary gland, adrenocorticotropic hormone (ACTH) is released.
ACTH binds to receptors on the adrenal cortex and stimulates adrenal release of cortisol. In response to stressors, cortisol will be released for several hours after encountering the stressor.
At a certain blood concentration of cortisol this protection is ostensibly achieved and the cortisol exerts negative feedback to the hypothalamic release of CRF and the pituitary release of ACTH (negative feedback). At this point, systemic homeostasis returns.

STRESS RESPONSES

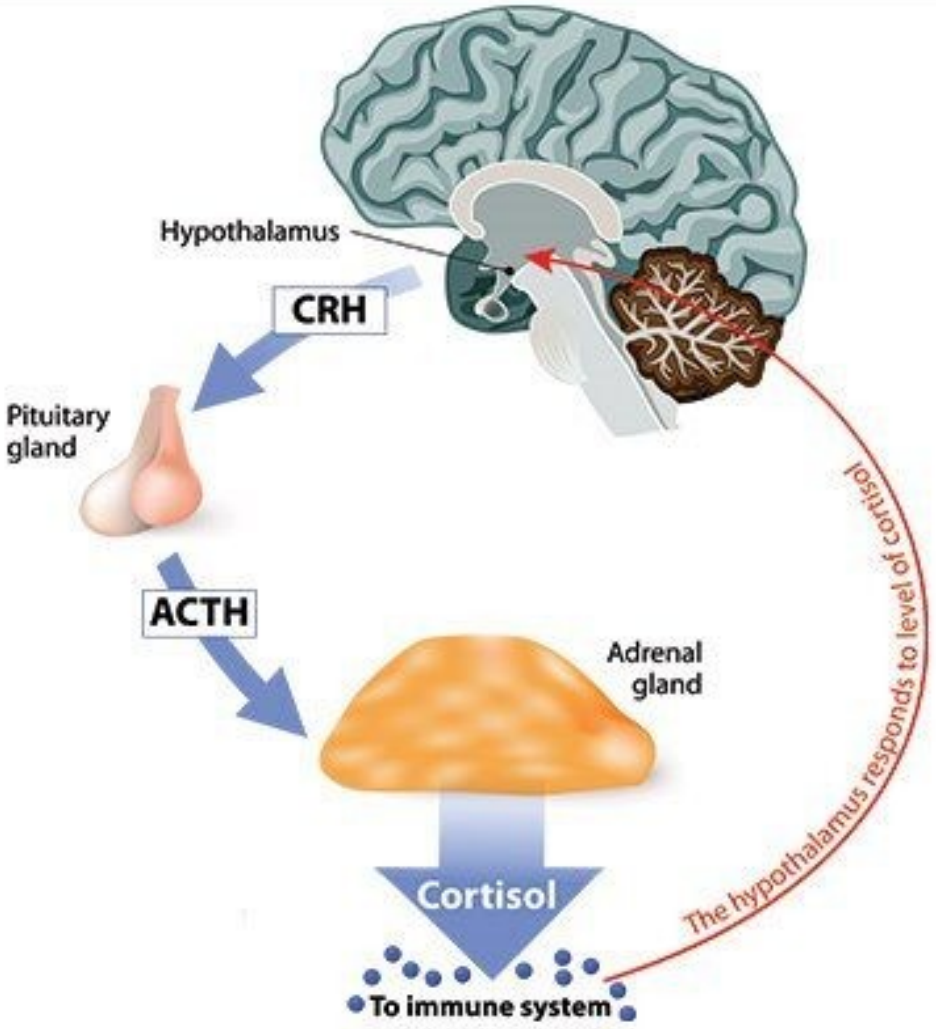


HPA axis in central Stress Response System

Flowchart of ACTH (adreno cortico tropic hormone) axis

1. Perception of Stressor
2. Signals stimulate Hypothalamus
3. Hypothalamus releases Corticotrophin releasing factor (CRF)
4. CRF send to pituitary gland in turn stimulates anterior pituitary cells
5. ACTH is released to the blood stream
6. ACTH stimulates the cells in outer layers of adrenal gland
7. Adrenal cortex cells secrete corticoid hormones, such as cortisol
8. Cortisol promotes glucose formation by breaking fats and protein (over activity)
9. The above impairs body's defence to infection

STRESS RESPONSES



HPA axis in central Stress response system

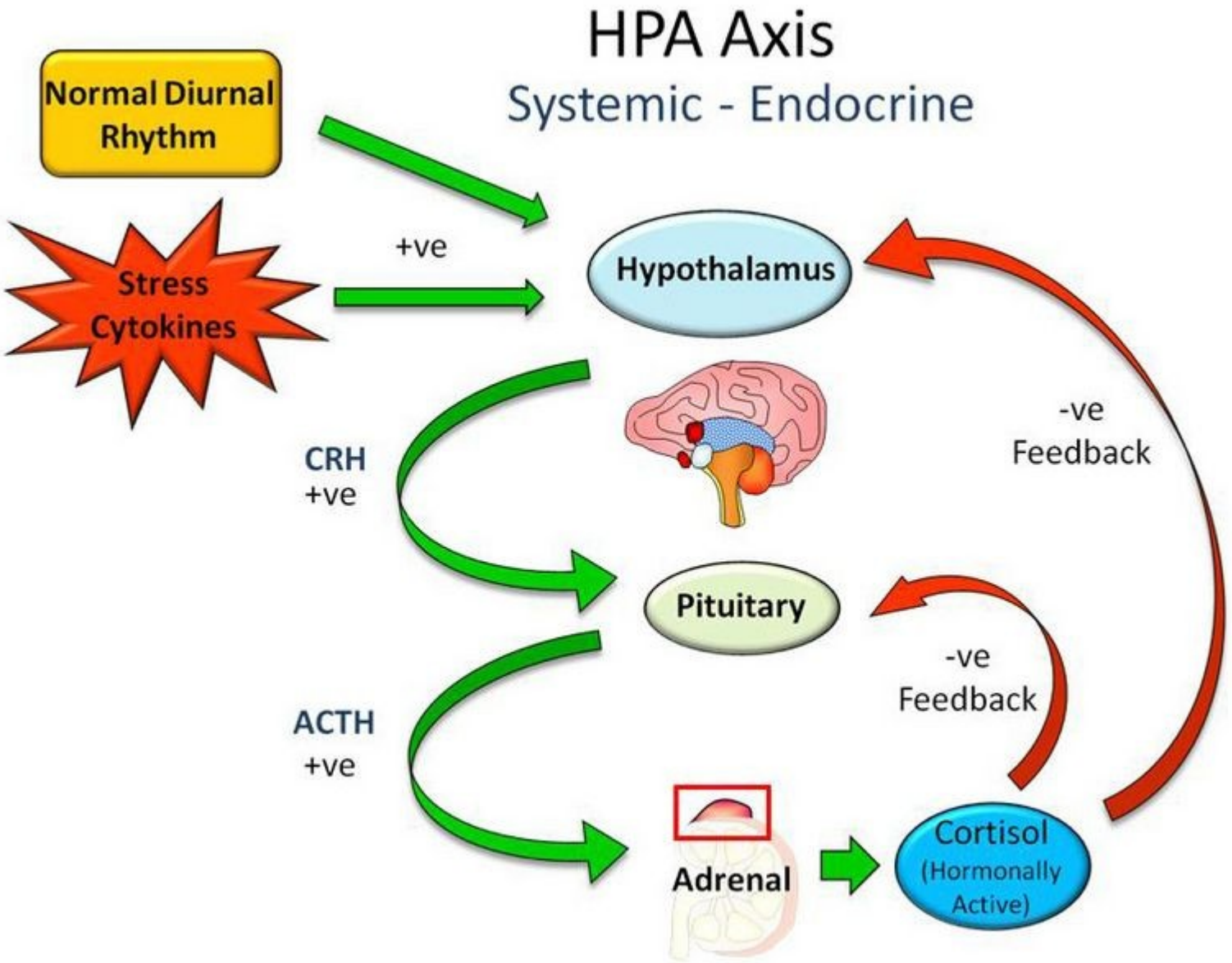
- With repeated exposure to stressors, the organism habituates to the stressor with repeated and sustained HPA axis activation. Therefore, it is important to support healthy cortisol levels in order to ensure the hypothalamus and pituitary glands maintain the appropriate level of sensitivity to the negative feedback of cortisol.

- Secretion of alarm chemicals such as epinephrine and norepinephrine from the adrenal medulla, as well as HPA axis activation persists along with the secretion of CRF, ACTH, and cortisol.

- Interestingly, with aging, the hypothalamus and pituitary are less sensitive to negative feedback from cortisol and both ACTH and cortisol levels rise as we age.

- Older women secrete more cortisol in response to stress than do older men. Young women, however, produce lower levels of

HPA axis in central Stress



HPA axis in central Stress response system

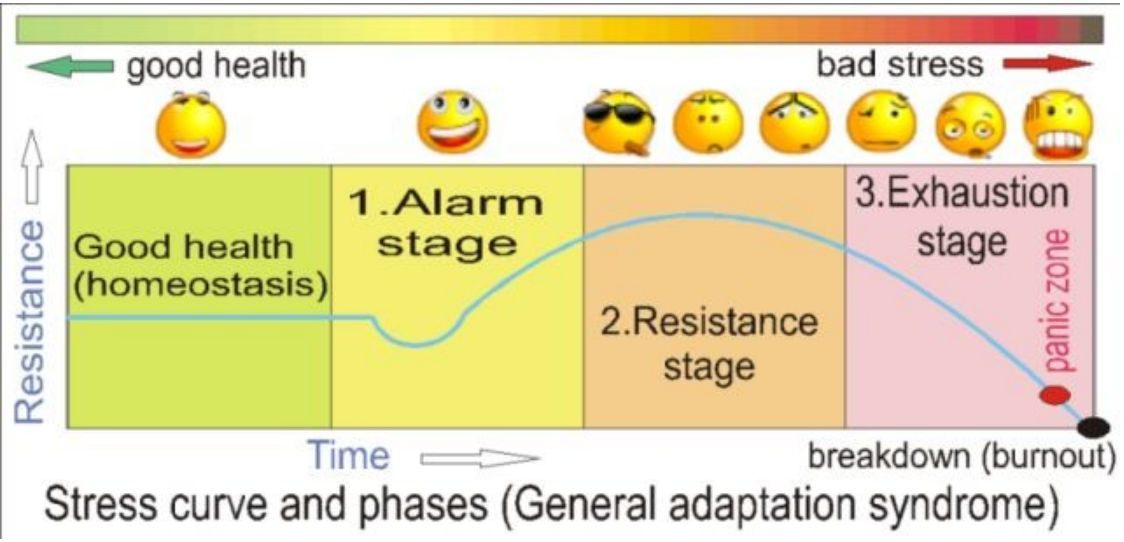
Under conditions of normal exposure to cortisol, our tissues only experience fleeting glimpses of the alarm catecholamines and cortisol.

As we are addressing the various health consequences of stress, it is imperative to also address the axis of response itself. Restoring homeostasis to the HPA axis is the primary goal of integrative care.

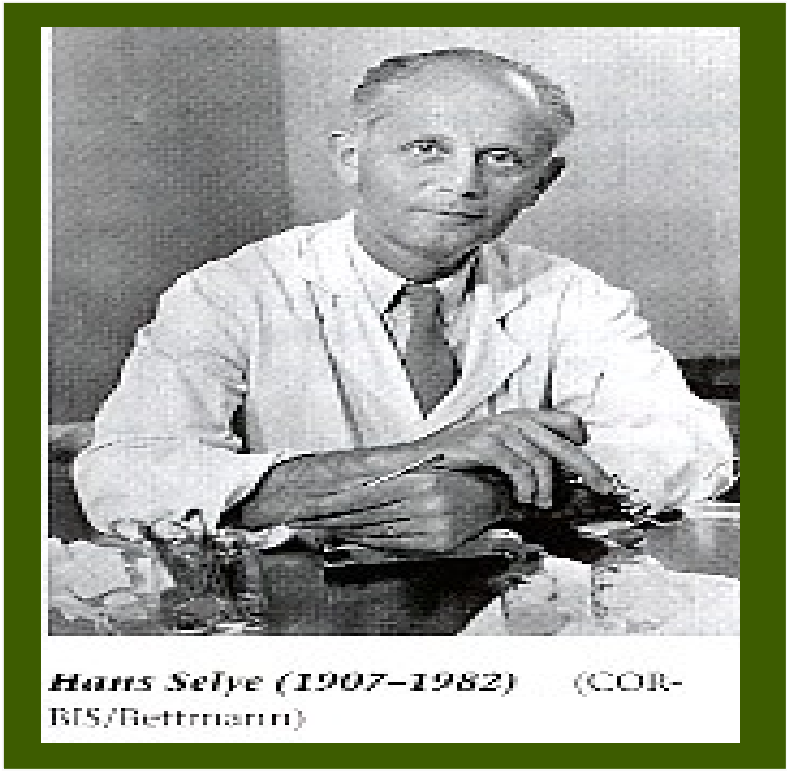
General Adaptation Syndrome (GAS)

- GAS is the three-stage process that describes the physiological changes the body goes through when under stress. Hans SelyeTrusted Source, a medical doctor and researcher, came up with the theory of GAS. During an experiment with lab rats at McGill University in Montreal, he observed a series of physiological changes in the rats after they were exposed to stressful events.
- With additional research, Selye concluded that these changes were not an isolated case, but rather the typical response to stress. Selye identified these stages as alarm, resistance, and exhaustion. Understanding these different responses and how they relate to each other may help you cope with stress.

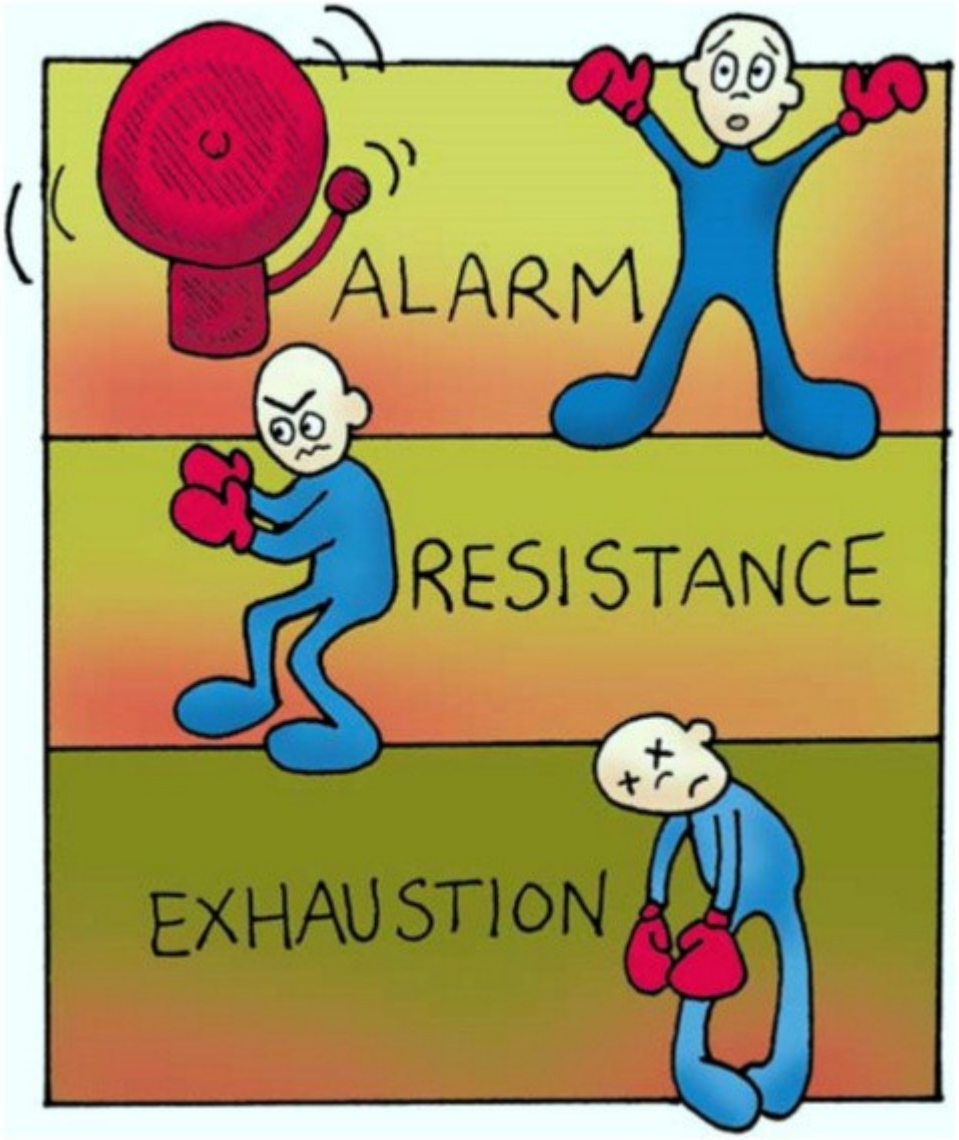
General Adaptation Syndrome



Stress curve and phases (General adaptation syndrome)


Hans Selye (1907–1982) (COR-BIS/Bettmann)

General Adaptation Syndrome



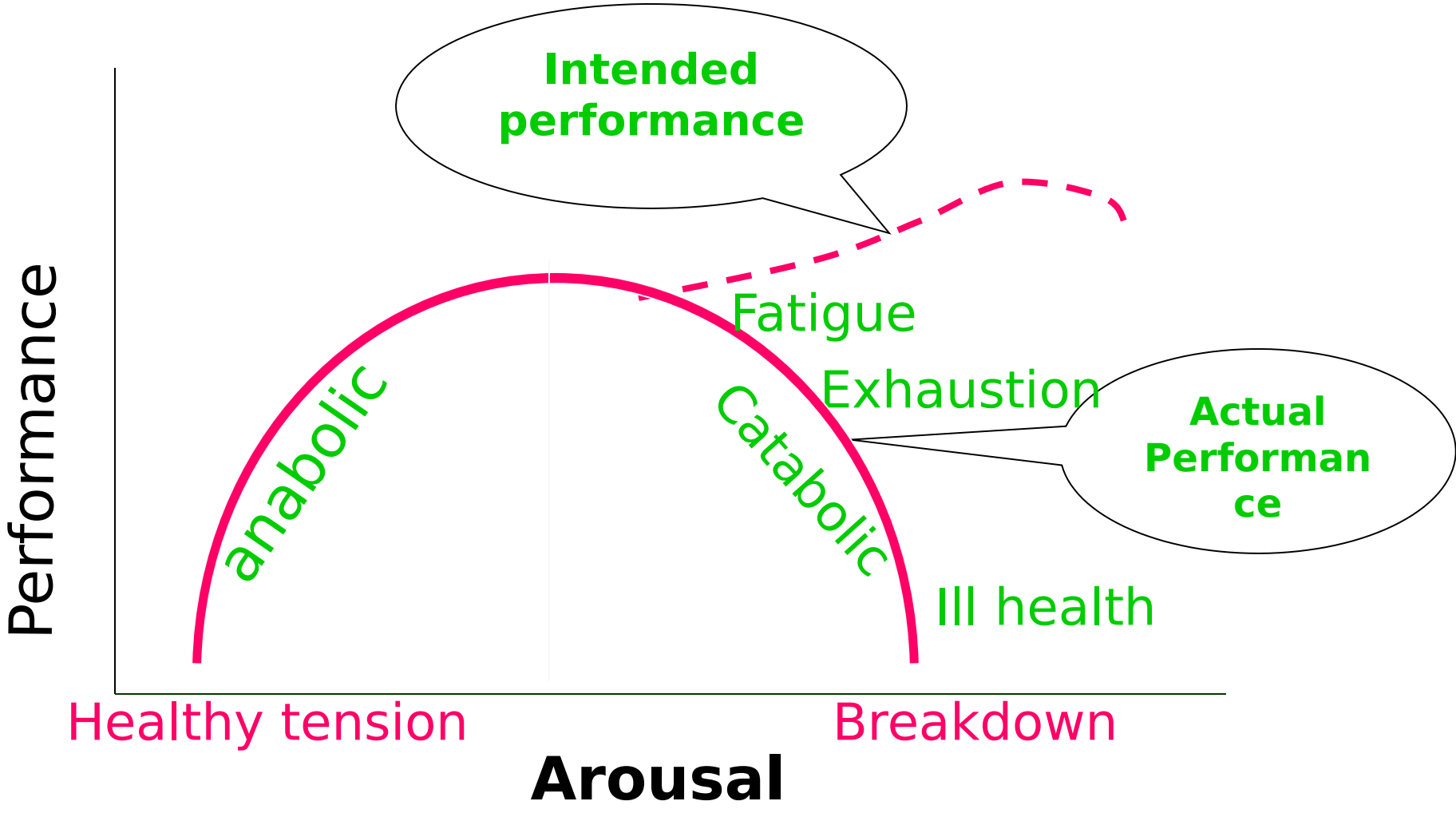
Three reactions or stages of stress

STRESS RESPONSES

General Adaptation Syndrome (GAS)

- Alarm Reaction
- Stage of resistance
- Stage of Exhaustion

Stress- Creative or Destructive?



HANS SELYE MODEL OF STRESS

General Adaptation Syndrome (GAS)

Alarm Reaction

- The alarm reaction stage refers to the initial symptoms the body experiences when under stress. You may be familiar with the “fight-or-flight” response, which is a physiological response to stress. This natural reaction prepares you to either flee or protect yourself in dangerous situations. Your heart rate increases, your adrenal gland releases cortisol (a stress hormone), and you receive a boost of adrenaline, which increases energy. This fight-or-flight response occurs in the

HANS SELYE MODEL OF STRESS

General Adaptation Syndrome (GAS)

Stages of Resistance

- After the initial shock of a stressful event and having a fight-or-flight response, the body begins to repair itself. It releases a lower amount of cortisol, and your heart rate and blood pressure begin to normalize. Although your body enters this recovery phase, it remains on high alert for a while. If you overcome stress and the situation is no longer an issue, your body continues to repair itself until your hormone levels, heart rate, and blood pressure reach a pre-stress state.

HANS SELYE MODEL OF STRESS

General Adaptation Syndrome (GAS)

Stages of Resistance

- Some stressful situations continue for extended periods of time. If you don’t resolve the stress and your body remains on high alert, it eventually adapts and learns how to live with a higher stress level. In this stage, the body goes through changes that you’re unaware of in an attempt to cope with stress.
- Your body continues to secrete the stress hormone and your blood pressure remains elevated. You may think you’re managing stress well, but your body’s physical response tells a different story. If the resistance stage continues for too long of a period without pauses to offset the effects of stress. this can lead to the

HANS SELYE MODEL OF STRESS

General Adaptation Syndrome (GAS)

Stages of Resistance

Signs of the resistance stage include:

- irritability
- frustration
- poor concentration

HANS SELYE MODEL OF STRESS

Stages of Exhaustion

- This stage is the result of prolonged or chronic stress. Struggling with stress for long periods can drain your physical, emotional, and mental resources to the point where your body no longer has strength to fight stress. You may give up or feel your situation is hopeless. Signs of exhaustion include:
- fatigue
- burnout
- depression
- anxiety
- decreased stress tolerance
- The physical effects of this stage also weaken your immune system and put you at risk for stress-related illnesses.

Research has indicated that 75% of human disease are stress prone disorders. They are mainly caused due to mental and emotional strains.

When does general adaptation syndrome occur?

- GAS can occur with any type of stress. Stressful events can include:
- a job loss
- medical problems
- financial troubles
- family breakdown
- trauma
- But while stress is unpleasant, the upside is that GAS improves how your body responds to stressors, particularly in the alarm stage.

When does general adaptation syndrome occur?

- The fight-or-flight response that occurs in the alarm stage is for your protection. A higher hormone level during this stage benefits you. It gives you more energy and improves your concentration so you can focus and tackle the situation. When stress is short-term or short-lived, the alarm stage isn’t harmful.
- This isn’t the case with prolonged stress. The longer you deal with stress, the more harmful it is to your health. You also don’t want to remain in the resistance stage for too long and risk entering the exhaustion stage. Once you’re in the exhaustion stage, prolonged stress raises the risk for chronic high blood pressure, stroke, heart disease, and depression. You also have a higher risk for infections and cancer due to a weaker immune system.

The takeaway

- Since it’s not possible to eliminate every stressor, it’s important to find ways to cope with stress. Knowing the signs and stages of stress can help you take appropriate steps to manage your stress level and lower your risk of complications.
- It’s essential for your body to repair and recover during the resistance stage. If not, your risk for exhaustion rises. If you can’t eliminate a stressful event, regular exercise can help you cope and maintain a healthy stress level. Other techniques for stress management include meditation and deep-breathing exercises.

Lazarus & Folkman's transactional model of stress

FOUNDERS

Richard S. Lazarus

Defined by Lazarus & Folkman in 1977, however was looked into earlier in the 1960s.

Susan Folkman

Lazarus and Folkman

Lazarus and Folkman (1984) define stress as a ralationship between the person and the environment that is appraised by the person as
taxing or exceeding his or her resources and endangering his or her well being.
A precipitating event is a stimulus arising from the internal or external environment and is perceived by the individual in a specific manner. Determination that a particular person/ environment relationship is stressful depends on the individual's cognitive appraisal of the situation.

Cognitive appraisal is an individual's evaluation of the personal significance of the event or occurrence. The event precipitates a response on the part of the individual, and the response is influenced by the individual's perception of the event. The cognitive response consists of a primary appraisal and a secondary appraisal.

INDIVIDUAL'S PERCEPTION OF THE EVENT

PRIMARY APPRAISAL: Lazarus and Folkman(1984) identify three types of primary appraisal: irrelevant , benign positive , and stressful. An event is judged irrelevant when the outcome holds no significance for the individual. A benign positive outcome is perceived as producing pleasure for the individual. Stress appraisals include harm/loss, threat, and challenge. Harm/ loss appraisals refer to damage or loss already experienced by the individual. Appraisals of a threatening nature are perceived as anticipated harm and losses. When an event is appraised as challenging, the individual focuses on potential for gain or growth, rather than on risks

INDIVIDUAL’S PERCEPTION OF THE EVENT

SECONDARY APPRAISAL: This secondary appraisal is an assessment of skills, resources, and knowledge that the person possesses to deal with the situation. The individual evaluates by considering the following:

- What coping strategies are available to me?

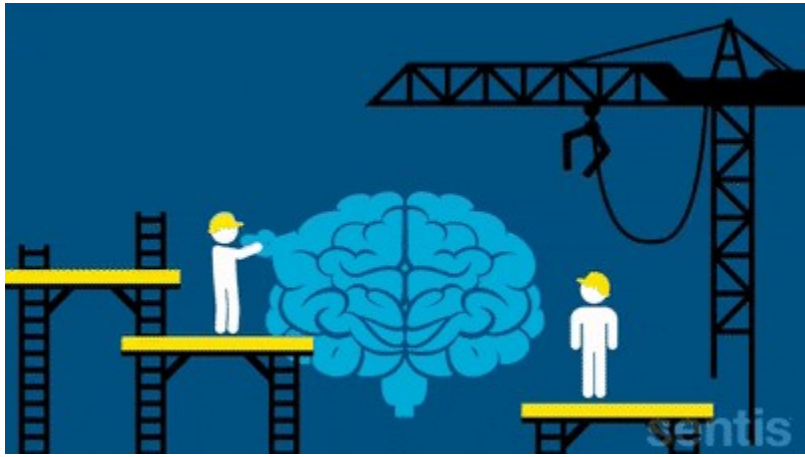
- Will the option I choose be effective in this situation?

- Do I have the ability to use that strategy in an effective manner?

This interaction between the primary appraisal of the event that has occurred and the secondary appraisal of available coping strategies determines the individual’s quality of

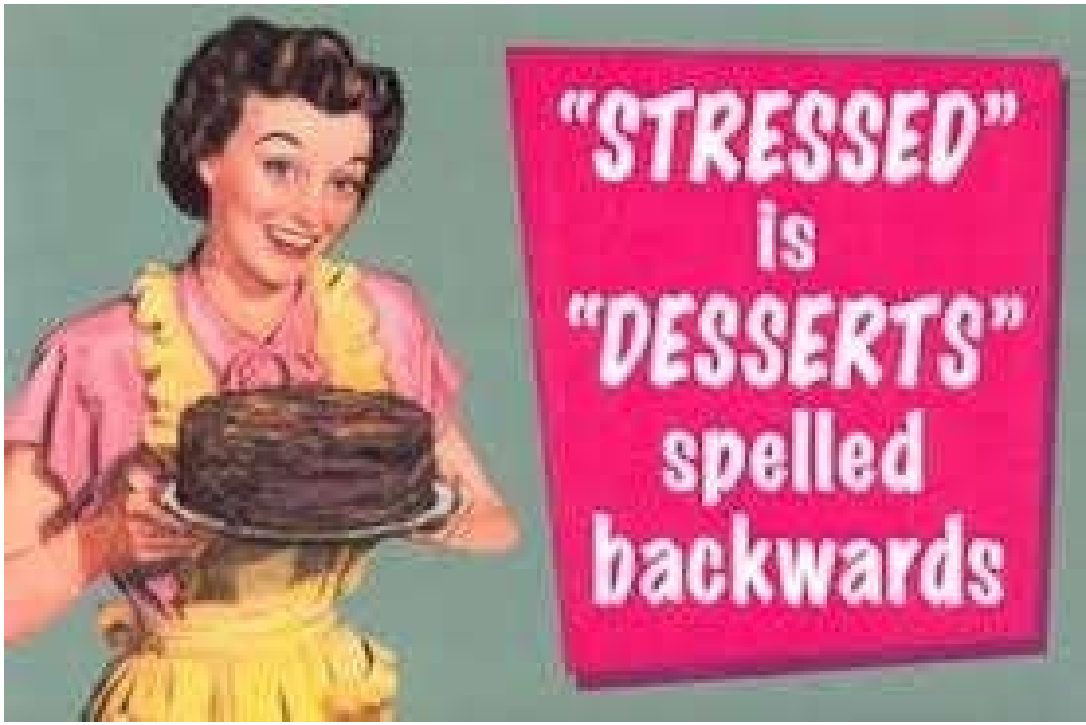
Lazarus & Folkman's transactional model of stress & coping

- **Transaction (interaction) occurs between a person & the environment**
  - **Stress results from an imbalance between (a) demands & (b) resources**
- **Thus we become stressed when demands (pressure) exceeds our resources (our ability to cope & mediate stress)**
- **Thus the interpretation of the stressful event was more important**



Primary Appraisal

- **Considers whether the person has a personal stake in encounter (are their goals dissatisfied)**
- **Evaluates the significance of the encounter – which either**
  1. **Has no significance for person**
  2. **Is a benign-positive encounter (desirable)**

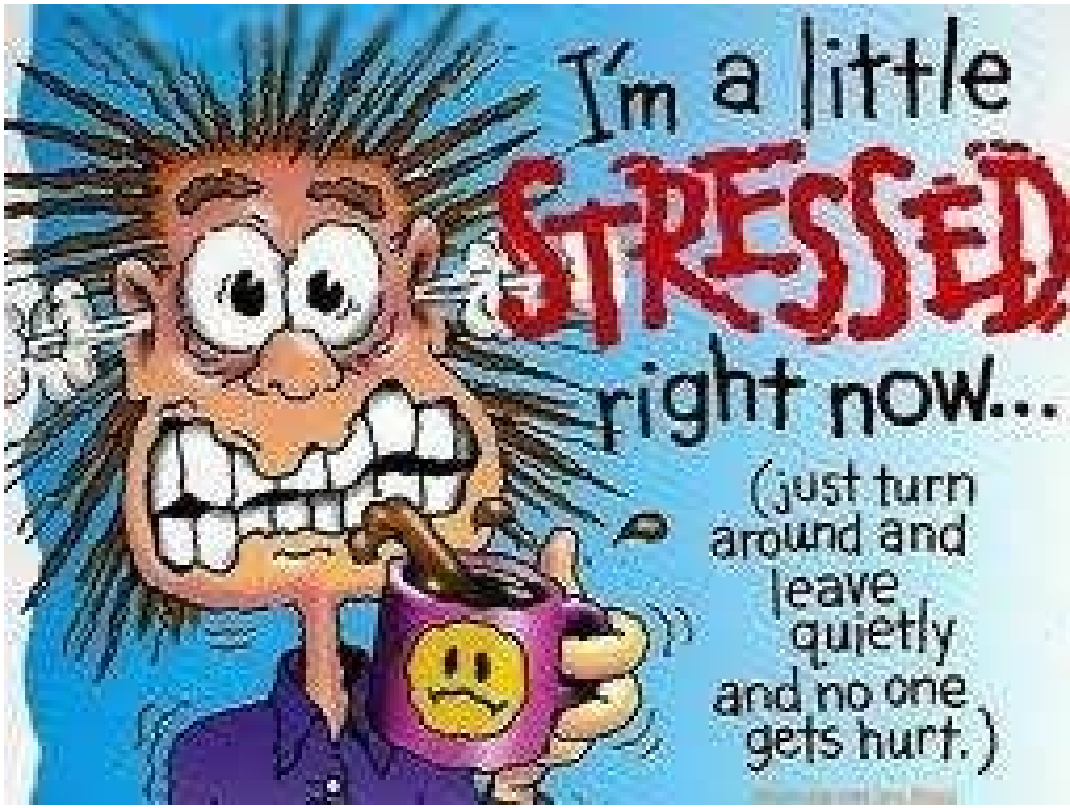


Primary appraisal – concerns relevance to our well-being

Primary Appraisal

- Stressful situations are appraised as involving

1. **Harm/ loss - that has occurred (so far)**
2. **Threats – i.e. potential future harm**
3. **Challenges – i.e. how can we learn/ gain**

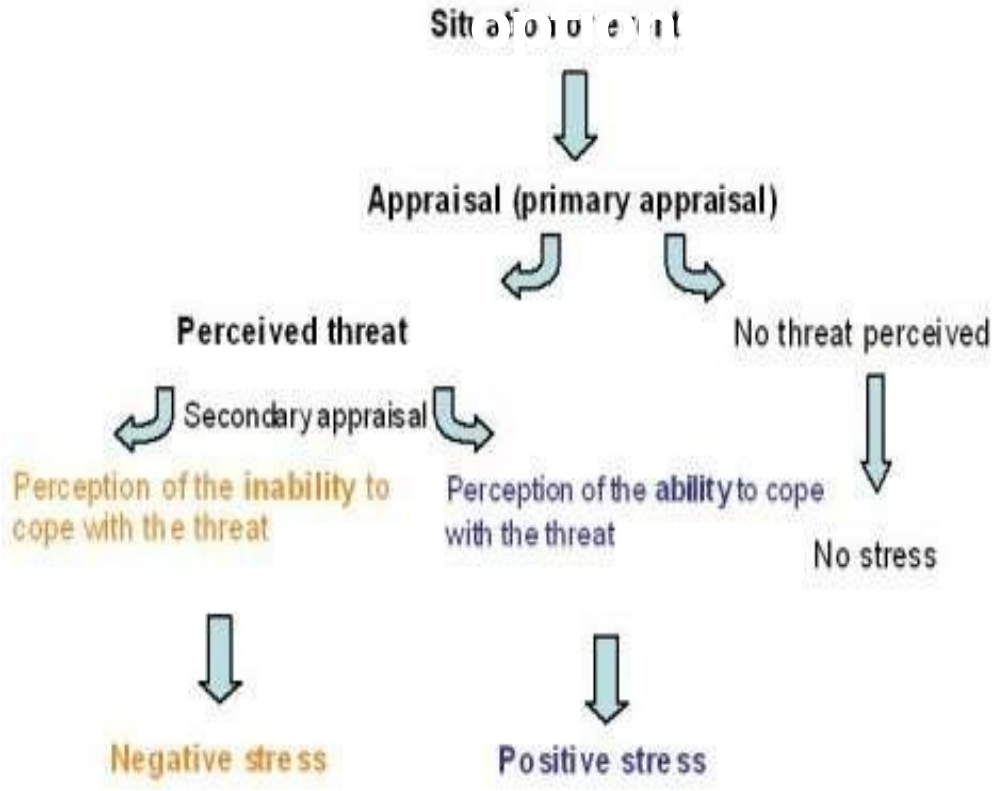


Secondary Appraisal

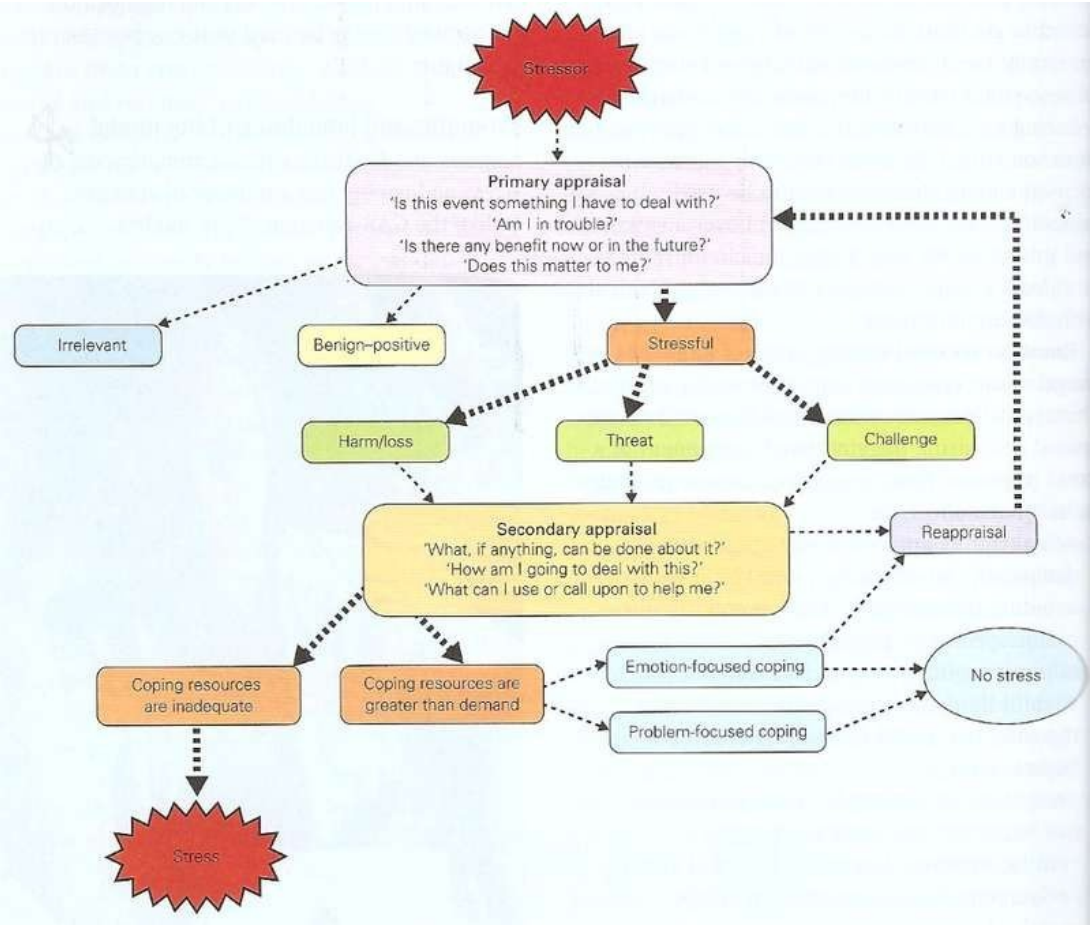
- **Individual will then engage in secondary appraisal to work out how we can best deal with situation & change undesirable conditions**
- **Evaluate internal/ external coping options as well as more specifically resources to create a more positive environment.**

1. **Internal options – e.g. will power, inner strength**
2. **External options – peers, professional health**

Secondary appraisal – concerns coping



Problem based-coping



Problem based-coping – attempts to change negative

- **Used when we feel we have control of the situation, thus can manage the source of the problem**
- **Thus our possible strategies could include:**
  1. **Defining the problem**
  2. **Generating, evaluating alternative solutions**
  3. **Learning new**

Emotional based-coping

- **Used when we feel we have little control of the situation, thus we can't manage the source of the problem**
- **Involves gaining strategies for regulating emotional distress – e.g.**

1. **Avoiding – 'I'm not going to school'**
2. **Distancing yourself from the emotion 'I'm not stressed, it doesn't matter'**
3. **Acceptance – 'I failed the exam, but I still have 4 other subjects'**
4. **Seeking emotional support from your partner**
5. **Selective attention**

Emotion based-coping – attempts to reduce negative emotional state/ appraisal of

Strengths & Weaknesses of model

Strengths

- **It considers Cognitive approaches as opposed to fight-flight, GAS (controlled by Autonomic.N.S)**
- **It's a dynamic model – i.e. if factors in the ability for the individual to change their appraisal and thus their response**
- **It caters for individual differences i.e. the manner in which we appraise and cope with stressor varies enormously.**
- **Identifies alternative methods for managing psychological responses to stressors**

Weaknesses

- **Lack of empirical evidence**
- **Overlap of primary & secondary appraisals**

Thank you